ATTACHMENT VI-2

Statistical Analysis of Ground Water Monitoring Data

1. The Permittee shall perform statistical analysis of all ground water monitoring data in accordance with the attached, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim final Guidance, February 1989.

2. The Permittee shall enclose a copy of statistical analysis performed in the annual report.

Excerpts from the

STATISTICAL ANALYSIS OF GROUND-WATER MONITORING DATA AT RCRA FACILITIES

INTERIM FINAL GUIDANCE

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February 1989

6.2.1 Confidence Intervals

When a regulated unit is compliance monitoring with a fixed compliance limit (either an MCL or an ACL), confidence intervals are the recommended procedure pursuant to paragraph 264.97(h)(5) in the Subpart F regulations. The unit will remain in compliance monitoring unless there is statistically significant evidence that the mean concentration at one or more of the downgradient wells exceeds the compliance limit. A confidence interval for the mean concentration is constructed from the sample data for each compliance well individually. These confidence intervals are compared with the compliance limit. If the entire confidence interval exceeds the compliance limit, this is statistically significant evidence that the mean concentration exceeds the compliance limit.

Confidence intervals can generally be constructed for any specified distribution. General methods can be found in texts on statistical inference some of which are referenced in Appendix C. A confidence limit based on the normal distribution is presented first, followed by a modification for the log-normal distribution. A nonparametric confidence interval is also presented.

6.2.1.1 Confidence Interval Based on the Normal Distribution

PURPOSE

The confidence interval for the mean concentration is constructed from the compliance well data. Once the interval has been constructed, it can be compared with the MCL or ACL by inspection to determine whether the mean concentration significantly exceeds the MCL or ACL.

PROCEDURE

Step 1. Calculate the mean, X, and standard deviation, S, of the sample concentration values. do this separately for each compliance well.

Step 2. For each well calculate the confidence interval as

$$X \pm t(0.99, n-1)\, S/\sqrt{n}$$

where $t(0.99, n-1)$ is obtained from the t-table (Table 6, Appendix B). Generally, there will be at least four observations at each sampling period, so it will usually have at least 3 degrees of freedom.

Step 3. Compare the intervals calculated in Step 2 to the compliance limit (the MCL or

ACL, as appropriate). If the compliance limit is contained in the interval or is above the upper limit, the unit remains in compliance. If any well confidence interval's lower limit exceeds the compliance limit, this is statistically significant evidence of contamination.

REMARK

The 99th percentile of the t-distribution is used in constructing the confidence interval. This is consistent with an alpha (probability of Type I error) of 0.01, since the decision on compliance is made by comparing the lower confidence limit to the MCL or ACL. Although the interval as constructed with both upper and lower limits is a 98% confidence interval, the use of it is one-sided, which is consistent with the 1% alpha level of individual well comparisons.

EXAMPLE

Table 6-1 lists hypothetical concentrations of Aldicarb in three compliance wells. For illustration purposes, the MCL and Aldicarb has been set at 7 ppb. There is no evidence of nonnormality, so the confidence interval based on the normal distribution is used.

TABLE 6-1. EXAMPLE DATA FOR NORMAL CONFIDENCE INTERVAL--
ALDICARB CONCENTRATIONS IN COMPLIANCE WELLS (ppb)

	Sampling data	Well 1	Well 2	Well 3
	Jan. 1	19.9	23.7	5.6
	Feb. 1	29.6	21.9	3.3
	Mar. 1	18.7	26.9	2.3
	Apr. 1	24.2	26.1	6.9
	X =	23.1	24.6	4.5
	S =	4.9	2.3	2.1

MCL =7 ppb

Step 1. Calculate the mean and standard deviation of the concentrations for each

compliance well. These statistics are shown in the table above.

Step 2. Obtain the 99th percentile of the t-distribution with (4-1) = 3 degrees of freedom from Table 6, Appendix B as 4.541. Then calculate the confidence interval for each well's mean concentration.

Well 1: $23.1 \pm 4.541(4.9)/\sqrt{4} = (12.0, 34.2)$
Well 2: $24.6 \pm 4.541(2.3)/\sqrt{4} = (19.4, 29.8)$
Well 3: $4.5 \pm 4.541(2.1)/\sqrt{4} = (-0.3, 9.3)$

where the usual convention of expressing the upper and lower limits of the confidence interval in parentheses separated by a comma has been followed.

Step 3. Compare each confidence interval to the MCL of 7 ppb. When this is done, the confidence interval for Well 1 lies entirely above the MCL of 7, indicating that the mean concentration of Aldicarb in Well 1 significantly exceeds the MCL. Similarly, the confidence interval for Well 2 lies entirely above the MCL of 7. This is significant evidence that the mean concentration in Well 2 exceeds the MCL. Thus, there is no statistically significant evidence that the mean concentration in Well 3 exceeds the MCL.

INTERPRETATION

The confidence interval is an interval constructed so that it should contain the true or population mean with specified confidence (98% in this case). If this interval does not contain the compliance limit, then the mean concentration must differ from the compliance limit. If the lower end of the interval is above the compliance limit, then the mean concentration must be significantly greater than the compliance limit, indicating noncompliance.

END OF ATTACHMENT VI-2